

Szilard the Demon Slayer: Live Long 2nd Law

In the eighteen hundreds, Maxwell, in his work on the theory of heat, hypothesized an intelligent being (a "demon") who sits at a gate between two chambers of a gas only allowing hot (higher energy) particles in the left chamber and cold (lower energy) particles in the right chamber. The idea is that this demon, just by *knowledge* of which particles are hot and which are cold, can thus result in a *decrease of entropy* – or the creation of a temperature gradient of a gas from an equilibrium configuration. This is a violation of the second law of thermodynamics which says that entropy can only increase (or remain as is), i.e. $dS \geq 0$, and so makes a perpetual motion machine of the second kind–

One way out from this contradiction is that the entropy of the demon's body increases when it acquires the information **by more than** what the gas system would decrease such that in total, the combined demon's + gas's system's entropy would only increase. This is not a trivial fact!

The first to demonstrate this was Leo Szilard in the 1930s who showed that this was indeed the case!

The main goal of the talk will be to go over Szilard's seminal paper: [On The Decrease of Entropy in a Thermodynamic System By the Intervention of Intelligent Beings](#).

The talk will be divided into three (unequal) parts:

- Quick review of thermodynamics.
- The meaning of entropy and the work value of information.
- Szilard's engine and a proof that $dS \geq 0$ for a system with such a demon.